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Effects of Crossword-Picture Puzzle Teaching Strategy and Gender on Students' Attitude to Basic Science

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Abstract:
This paper investigated the effects of crossword-picture puzzle (CPP) and gender on students' attitude to Basic Science. A pretest-posttest quasi experimental design was adopted. The sample comprised 389 JSS II Basic Science Students from nine schools randomly selected in three States (Oyo, Ogun and Ondo) in Southwestern Nigeria. Four instruments used were- Teachers' Instructional Guides for: Crossword-Picture Puzzle Teaching Strategy, Conventional Lecture Method; Basic Science Students' Attitude Scale (r=0.80); and Evaluation Sheets for assessing research assistants. Three hypotheses were tested at 0.05 level of significance. Data were analysed using ANCOVA and mean scores. Results revealed that treatment had significant main effect on students' attitude to basic science ($F_{(2,389)} =11.51$; $p<0.05$; $\eta^2=.06$). Crossword-picture puzzle enhanced attitude scores ($\bar{x} =58.43$) than Conventional Lecture Method ($\bar{x} =52.08$). Gender had no significant main effect on students' attitude scores ($F_{(1,389)} =.404$; $p>.05$; $\eta^2=.001$). The interaction effect of treatment and gender on attitude scores was not significant ($F_{(2,389)} =.477$; $p>.05$; $\eta^2=.003$).Crossword-picture puzzle strategy is therefore, recommended to be adopted by Basic Science teachers and curriculum planners in enhancing students' attitude to Basic Science.

Keywords*: crossword-picture puzzle, attitude, gender, Basic Science, southwestern Nigeria*

1. Introduction

The 9-Year Basic Education Curriculum emerged from a meeting of experts held between January and March 2006 and array of workshops organized by Nigerian Educational Research and Development Council, NERDC (NERDC, 2007). This curriculum was expected to ensure continuity and flow of themes, topics and experiences from primary school to junior secondary school levels. The 9-Year Basic Education Curriculum is divided into basic levels: Lower Basic Level- Primaries 1-3, Middle Basic Level- Primaries 4-6 and Upper Basic Level- JSS 1-3.The above new curriculum structure was approved by the National Council on Education (NCE) based on the following reasons: (i) The decision of the Federal Government to introduce the 9-Year Basic Education Programme (ii) The need to attain the Millennium Development Goals (MDGs) by 2015 (iii) The need to implement the National Economic and Empowerment. Development Strategies (NEEDS) summarized as: Value reorientation, Poverty eradication, Job creation, Wealth generation and using education to empower the people. It then became necessary that the former curricula for both primary and junior secondary schools be reviewed, re-structured and re-aligned to fit into a 9-Year Basic Education Programme. The new curriculum reflects depth, appropriateness, and inter-relatedness of the curricula contents. Not only these but emerging issues which covered value reorientation, family life, HIV/AIDS education, entrepreneurial skills were also infused into the curriculum. The 9-Year Basic Education Programme gave rise to Basic Science (formerly referred to as Integrated Science). In selecting the contents of this Basic Science curriculum, globalization, Information/communication technology and entrepreneurship education were identified as fundamental issues shaping the development of nations worldwide and influencing the world of knowledge were considered for the approval of four curriculum innovations (Adeniyi, 2007) which are: Environmental Education, Drug Abuse Education, Population and Family Life Education, Sexually Transmitted Infection (STI, HIV/AIDS). The overall objectives of this curriculum centre on the learners. These objectives are: development of interest in science and technology; acquisition of basic knowledge and skills; application of scientific and technological knowledge and skills to meet societal needs; taking advantage of the numerous career opportunities offered by science and technology and becoming prepared for further studies in science and technology. In order to achieve a holistic presentation of science and technology contents to learners, four themes were used to cover cognitive (knowledge), psychomotor (skills) and affective (attitudinal) domains of learning. For primary Basic Science and Technology, the themes are: You and Environment, Living and Non-Living Things, You and Technology, You and Energy. At the Upper Basic Level (JSS 1-3), theme '3' You and Technology was changed to "Science and Development" (NERDC, 2007) to allow Basic Technology to run as an independent subject. Hence, Basic Science themes at this level are: You and Environment, Living and Non-Living Things, Science and Development, You and Energy. The spiral nature of these themes makes sure that contents become gradually difficult as learners progress from primary level (1-3, 4-6) to junior secondary level (1-3) (NTI, 2010).

This then suggests that the level of difficulty of various concepts and topics in Basic Science becomes aggravated if Basic Science class lacks appropriate teaching strategy and desirable attitude on the part of students regarding the subject. Basic Science has not been taught in a way that helps to achieve its desired objectives. By implication, Basic Science is taught traditionally following the conventional mode of chalk and talk resulting in students' low learning and interest. Hence, Basic Science lacks appropriate method to convey scientific knowledge, attitude and skills to learners. This is why Ogundiwin (2013) suggested other strategies that could improve students' attitude and bring about effective Basic Science delivery. One of such strategies is crossword-picture puzzle teaching strategy. Researchers in the past have ascertained the effectiveness of using educational puzzle game to teach science (Scott, 2002; Scott, 2006; Bolorunduro, 2005). Educational games have inherent potential to: arouse and sustain interest in learning; excite learners; generate new ideas in learners; teach difficult science concepts; remove fatigue; foster social interaction; recall information easily and generally help learners with low achievement potential. One of the goals of science education is to encourage students to have favorable attitudes towards science. Effort needs to be concentrated on fostering desirable attitudes toward science and the teaching of science (Lucas and Dooley, 2006). Attitude toward science is closely related to achievement in science (George, 2000). Attitude toward science predicts achievement in science (Kan and Akbas, 2006). Positive attitude/favorable attitude may lead to significant/higher achievement in science. The attitude of the teachers, to a large extent, affects achievement and attitude of students in science (Adetunji, 2000; Abram, 2004). Attitude plays a vital role in the life of an individual. Adediwura and Bada (2007) defined attitude as a consistent tendency to react in a particular way-often positively or negatively towards any matter. According to Aremu and Sangodoyin (2010) students have negative attitude to learning. Studies hold different views on students' attitude. Bolorunduro (2005) found that female students had better attitude to Integrated Science than male students. Afuwape (2002), Akinsola (2007), results revealed a significant main effect of simulation-game on students' attitude whereas Akuche (2008) reported no significant effect of four instructional strategies on attitude. Kresse (2010) is of the view that when students have positive attitudes about science, they will be more open to exploring and gaining knowledge in these areas. This researcher further acclaimed that using effective strategies for improving students' attitudes in science is important because science is an exciting, fascinating and useful subject. Establishing positive attitudes toward science is therefore important to the educational community as a whole. Since the research reports on attitude are not consistent, the present study therefore, considered attitude as an important variable investigated. Mixed reports abound from fields of research on gender issue. Akpinar, Yildiz, Tatar, and Ergin (2009); Ajitoni (2004); Bolorunduro (2005) findings revealed that there were significant differences between female and male students in terms of attitude in favour of female. Okoruwa (2007) investigated effects of conceptual change and enhanced explicit teaching strategies on learning outcomes in primary science. One hundred and ninety primary six pupils were sued. The result revealed no significant moderating effect of gender on achievement but it was significant on attitude. Since research findings on gender related issues are inconclusive, study on gender is still relevant.

2. Statement of Problem

Students' motivation to learn science is declining resulting in poor performance in both internal and external examinations. This has been attributed to inappropriate mode of instruction that is traditional in nature. Scholars have recommended the use of strategies different from a conventional mode that promote Basic Science learning in a well-motivated environment. One of such strategies is crossword-picture puzzle teaching strategy. Researchers have proved its effectiveness in literature in improving instruction in classrooms but there is paucity of research on its effects on students' achievement in Basic Science especially in Southwestern Nigeria. Therefore, this study investigated the effects of Crossword-Picture Puzzle and gender on students' attitude to Basic Science in Southwestern Nigeria.

Hypotheses

- There is no significant main effect of treatment on Students' attitude to Basic Science.
- There is no significant main effect of Gender on Students' attitude to Basic Science.
- There is no significant interaction effect of treatment and Gender on Students' attitude to Basic Science.

3. Scope of the Study

The study covered nine junior secondary schools in Southwestern Nigeria (Oyo, Ogun and Ondo). The study focused on the effect Crossword-Picture Puzzle teaching strategy and gender on students' attitude to Basic Science. Only public junior secondary schools in Oyo, Ogun and Ondo; South-western Nigeria used for the study. The content coverage was limited to six concepts in the JSS 2 Basic Science curriculum following thematic approach to content organization: You and The Environment (Drug Abuse); Living things and Non-living things (Habitat, Respiration, changes in matter); Science and Development (Information and Communication Technology); You and Energy (Heat Energy). The study was delimited to the effect of gender on JSS 2 students' attitude to Basic Science.

4. Methodology

A pretest, posttest, control group, quasi-experimental design was adopted to collect data for this study. The treatment operated at two levels-one experimental and one control group. The sample consisted of 389 JSS 2 Basic Science students randomly selected from nine schools in Southwestern Nigeria. The intact classes of students were randomly assigned to two treatment groups-Crossword-Picture Puzzle teaching strategy group and Control group. Instruments for Data Collection The researchers prepared Basic Science Students' Attitude Scale, BSSAS. The scale sets out to collect information on students' opinion for each statement on class assignment, scientific activities, science classes, and Basic science teacher. Respondents indicated their opinion on a 4-point Likert scale. The scales were strongly Disagree (SD), Disagree (D), Agree (A) and strongly Agree (SA). The weights were SD(1), D (2), A (3), SA (4) for favourable statements while for unfavourable statements, the weights were assigned as follows: SD(4), D(3), A(2), SA(1). There were 25 items in this instrument. The initial thirty five (35) items were given to higher degree

students and experts who are in the field of science Education for face and content validity and relevance to the purpose of research. The researcher came up with 25 items with a reliability index of 0.80 using Cronbach alpha.
The researchers prepared Teachers' Instructional Guide for Crossword-Picture Puzzle-Based Teaching Strategy (TIGCPP). This instrument comprised lessons for the eight weeks of treatment. The specific features of this guide are: small group experiment, individual experiment, the use of laboratory apparatus, the use of game with picture puzzles and crossword puzzles. To ascertain the face and content validity of the instrument, two lecturers from Science unit in the department of Teacher Education, Faculty of Education, university of Ibadan, Ibadan, were given copies of the instrument for close examination. Their suggestions were used to produce the final copy of the instrument. The researchers also prepared Teachers' Instructional Guide for Conventional Lecture Method (control) (TIGCLM). This instrument was a traditional teaching method. The instrument was given to two experienced junior secondary school teachers in the field of Basic Science to ensure its face and content validity. The instrument was made valid subject to their necessary corrections and approval. The researcher also prepared Evaluation Sheets for Assessing Teachers' Performance during Training, ESATPT. This was meant to assess the research assistants' performance during the course of the training. The instrument contained personal data of the research assistants which are: School, Gender and criteria to evaluate. The instrument was placed on four point likert scale as follows:
Very High- 5
High – 4
Moderate – 3
Low – 2
Very Low - 1
This instrument was given to the experts and peers that are in the field of science Education. Their comments, criticism and scholarly contributions and suggestions were used to modify the items. This ascertained the appropriateness and relevance of the method to the target population.

4.1. Pre-treatment and Treatment Activities
There was visitation made by the researchers to Ministries of Education and schools for the first one week. Two weeks were used for the training of research assistants. Training was done step by step using the teaching guides on: Crossword-Picture Puzzle-Based Teaching Strategy and Conventional Lecture Method (control). Next one week for pretest. All the students in the class involved in all the nine (9) representative schools were used for the experiment and were given a pretest on the evaluative instrument- Basic Science Students' Attitude Scale, BSSAS. The treatment lasted for eight weeks. The treatment was carried out on the experimental and control groups. During this period, students were taught six selected concepts in Basic Science using a double period with each single period lasting 40 minutes. The last one week was used for the administration of posttest after treatment using Basic Science Students' Attitude Scale. This makes a total of thirteen (13) weeks.

4.2. Experimental Group
The treatment here involved two phases (following Teachers' Instructional Guide for Crossword-Picture Puzzle-Based Teaching Strategy, TIGCPPTS) -inquiry, question and answer and games (crossword and picture puzzles). For inquiry, question and answer, questions were asked from students to help students understand a given idea, concept, principle, etc. Students were divided into small groups of 4-5 members. Students followed written instructions, manipulated apparatus, and classified quantities, took measurements of quantities, recorded observations, inferred from results and reported activities individually. In phase 2 which was game (Crossword and Picture Puzzles), students were divided into small groups of 4-5 members, followed verbal instruction on games, manipulated games, recorded score in games and winner of games recognized.
There were rules for playing the game.

4.2.1. Rules for playing the game-Picture puzzle (Group work)
There were two pieces of picture puzzle. One was labeled and the other one not labeled. A member of group was asked to pick a number. The picture pieces (from students' content note) that corresponded to this number would be given to the group to solve the puzzle. Five (5) minutes was given to the group to study the labeled piece after which it was withdrawn and was given the other piece which was not labeled to complete the puzzle by fixing the labels on the picture using another Five (5) minutes.

4.2.1. Rules for playing the game-Crossword puzzle (Individual work)
Individual student was given crossword puzzle on the given topic. Individual student was asked to form specific number of words (e.g. at least 10 words) in a specific time (e.g. 5 minutes) using the crossword puzzle.

4.3. Control Group
The treatment here involved conventional method (lecture method). The teacher followed Teachers' Instructional Guide for Conventional Lecture Method, TIGCLM. Method of Data Analysis Data collected were analyzed using ANCOVA and estimated marginal means of posttest scores to detect the differences in performance level.

5. Results

Hypothesis1: There is no significant main effect of treatment on Students' attitude to Basic Science.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig	Partial Eta Squared
Corrected Model	2543.864	18	141.326	3.302	0.000	0.140
Intercept	31162.117	1	31162.117	728.159	0.000	0.665
Preattscore	8.997	1	8.997	0.210	0.647	0.001
Treatment	984.711	1	492.356	11.505	0.000*	0.059
Gender	17.281	1	17.281	0.404	0.526	0.001
Mental ability	43.059	2	21.530	0.503	0.605	0.003
Treatment*Gender	40.842	2	20.421	0.477	0.621	0.003
Treatment*Mental ability	54.855	4	13.714	0.320	0.864	0.004
Gender*Mental ability	76.842	2	38.421	0.898	0.408	0.005
Treatment*Gender*Mental ability	107.741	4	26.935	0.629	0.642	0.007
Error						
Total	15663.242	371	42.796			
Corrected Total	1168904.000	390				
	18207.106	389				

Table 1: Posttest Attitude Scores of Students by Treatment and Gender

R Squared=0.140 (Adjusted R Squared=0.097) *significant at p<.05

Table 1 revealed that there was a significant main effect of treatment on students' attitude to Basic Science ($F_{(2,389)}$=11.505; p<.05;partial eta squared=.059). The effect size of 5.9% was fair. On this basis, hypothesis 1 was rejected. This means that the difference between the students' attitude score exposed to Crossword-Picture Puzzle Based Teaching and that of control group was significant.

Treatment	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Crossword-Picture Puzzle	58.433	1.001	56.465	60.400
Conventional	52.081	.896	50.319	53.843

Table 2: Estimated marginal means of posttest attitude score by Treatment and control group. Grand Mean=55.257

Table 2 revealed that students in the Crossword-Picture Puzzle Based treatment group had the highest adjusted posttest mean attitude score ($\bar{x}$ =58.433) followed by the students in the Conventional Lecture Method group ($\bar{x}$ =52.081). The grand mean being 55.257.

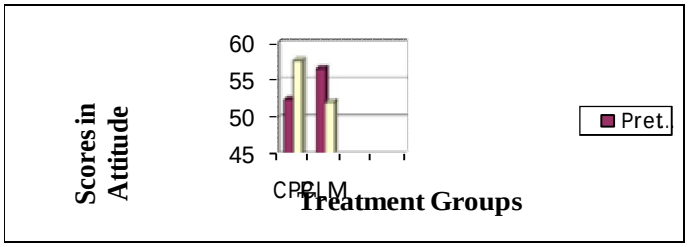

Figure 1: Chart Showing Attitude Scores According to Treatment

Hypothesis 2: There is no significant main effect of Gender on Students' attitude to Basic Science.

Table 1 revealed that there was no significant main effect of students' gender on their attitude scores ($F_{(1,389)}$=.404; p>.05; partial eta squared=.001). Hence, hypothesis 2b was not rejected.

Gender	Mean	Std.Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Male	55.210	.747	53.741	56.679
Female	54.560	.697	53.190	55.931

Table 3: Estimated marginal means of posttest attitude scores by Gender. Grand Mean=54.885

Male students had higher mean=55.210 while the female students had a lower mean=54.560, but the difference was not significant.

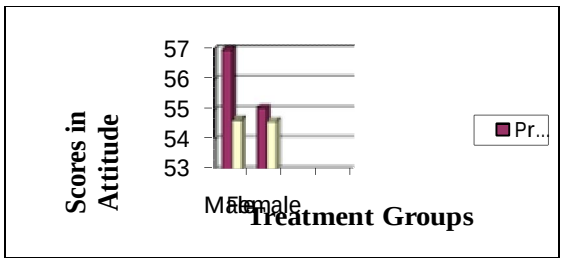

Figure 2: Chart Showing Attitude According to Gender

Hypothesis 4b: There is no significant interaction effect of treatment and Gender on Students' attitude to Basic Science.
Table 1 revealed that the interaction effect of treatment and gender on attitude scores was not significant ($F_{(2,389)}$ =.477; p>.05; partial eta squared=.003). The effect size of .3% was negligible. Hence, hypothesis 4b was not rejected.
Summary of Findings Mean achievement score of students exposed to Crossword-Picture Puzzle teaching strategy was significantly higher than that in the control group. Gender had no significant main effect on students' attitude to Basic Science
The two-way interaction effect of treatment and gender was not significant on students' attitude.

6. Discussion of Findings

The result of the study in Table 1 also revealed that treatment had a significant effect on students' attitude to Basic Science. This means that the difference between the attitude scores of students exposed to Crossword-Picture Puzzle Based Teaching and that of control group was differentially significant. Students in the Crossword-Picture Puzzle Based treatment group had the highest adjusted posttest mean attitude score ($\bar{X}$ =58.433) followed by the students in the Conventional Lecture Strategy group with the least adjusted attitude score ($\bar{X}$ =52.081). This agreed with Bolorunduro (2005) who reported that using Puzzle-based instructional strategy significantly enhanced attitude of students to Integrated Science. This result also lends credence to Afuwape (2002) who reported game significantly contributed to achievement of students in Integrated Science. The reasons for these results might be the game strategy and peer interaction employed which allowed the students to learn independently and then among the peer groups. The use of crossword puzzle for independent practice and picture puzzle for group practice in form of game stimulated their interest to learn consequently enhancing their favourable attitude to learn.
The result also revealed that gender had no significant effect on attitude. However, Male students had higher mean=55.210 while the female students had a lower mean=54.560, but the difference was not significant. This negated the work of Ajila (2003) and Okoruwa (2007) who reported gender, significant on attitude of students in Integrated Science and Primary Science respectively. Males having slightly higher performance than their female counterparts in this work could be probably attributed to males' domineering tendencies during instructional process. This is further explained on the basis of their tendencies to dominate discussions, always to lead and not ready to be led, their confidence and enthusiasm to approach new situation while the reason for females' underachievement with respect to attitude in this study could be that they are easily discouraged and depressed when they are exposed to new situation.
Results of the study showed no significant 2-way interaction effects of treatment and gender on students' attitude to Basic Science. The results tend to suggest that treatment especially crossword-picture puzzle accounts for the improved attitude of students to Basic Science and then should be adopted by the practicing teachers.

7. Educational Implications

From the findings of this study, it is evident that it is possible to use crossword-picture puzzle as an alternative strategy of instruction at Junior Secondary school level. Crossword-picture puzzle could produce improved attitude to Basic Science than the conventional lecture method that is often used. The findings of the study would also assist the students to have an improved attitude to Basic Science, Basic Science teacher, Basic Science Assignments and Scientific Activities.
The results of the study would motivate teachers to adopt and use strategies that enhance Basic Science achievement and the development of favourable attitude.

8. Conclusion and Recommendations

The study found that Crossword-Picture Puzzle-Based Teaching strategy was more effective than the Conventional Lecture Method in improving students' attitude to Basic Science. Based on the findings of this study, the following recommendations are made. To improve students' attitude to Basic Science, crossword-picture puzzle should be adopted in secondary schools.
Because of the potential benefits of educational game to motivate students during classroom instructional process, teachers should integrate game into their lessons especially puzzle game for effective instruction in Basic Science.
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